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14. ABSTRACT

Recently a research program to measure hearing thresholds with two California sea lions (Zalophus californianus) was initiated at the Space and Naval Warfare (SPAWAR) Systems Center in San Diego, California. This research was designed to assess the effects of dive depth and the resultant increase in static pressure on auditory sensitivity to a maximum depth of one hundred meters. One of the test subjects had a well-documented history of aggression towards handlers, and was considered unsuitable for open ocean work. Due to this unpredictable nature, he was kept separate from the other working animals in an enclosure with one older non-working animal. Because he was not being utilized by any of the other programs, a decision was made to employ this particular animal for the study. A detailed training program was devised utilizing a variety of free contact and confined contact handling techniques. While working with this animal in a free contact scenario, a consistent distance was maintained which effectively eliminated all stereotypical flight of defense/critical reactions towards the trainer. This paper will examine the results of this specialized approach and how the procedural methodology was incorporated into the experiment itself.
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UTILIZING FREE CONTACT TECHNIQUES WITH AN AGGRESSIVE CALIFORNIA SEA LION (*Zalophus californianus*) TO ESTABLISH HEARING THRESHOLDS IN THE OPEN OCEAN ENVIRONMENT.

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Recently a research program to measure hearing thresholds with two California sea lions *(Zalophus californianus)* was initiated at the Space and Naval Warfare (SPAWAR) Systems Center in San Diego, California. This research was designed to assess the effects of dive depth and the resultant increase in static pressure on auditory sensitivity to a maximum depth of one hundred meters. One of the test subjects had a well documented history of aggression towards handlers, and was considered unsuitable for open ocean work. Due to his unpredictable nature, he was kept separate from the other working animals in an enclosure with one older non-working animal. Because he was not being utilized by any of the other programs, a decision was made to employ this particular animal for the study. A detailed training program was devised utilizing a variety of free contact and confined contact handling techniques. While working with this animal in a free contact scenario, a consistent distance was maintained which effectively eliminated all stereotypical flight or defense/critical reactions towards the trainer. This paper will examine the results of this specialized approach and how the procedural methodology was incorporated into the experiment itself.

A NEED FOR A SPECIALIZED APPROACH

All wild animals have an escape reaction which is subject to definite laws, quantitatively and qualitatively. An animal displays this characteristic escape reaction on suddenly encountering an enemy. The reaction is specific for sex, age, enemy, and surroundings, and occurs as soon as the enemy approaches within a definite distance known as the *flight distance*. This condition is one of violent disturbance, and is sustained by the impulse to escape from the enemy. If followed and gradually overtaken, the animals flight reaction suddenly changes when the enemy comes within its *defense distance*. This is generally an attack, always with the character of self-defense, and is called the defense reaction. Finally, if circumstances prevent further escape (I. e. the animal becomes cornered, or feels that it is) a critical reaction takes place the moment the enemy reaches the *critical distance*. This critical reaction consists of an attack, with emergency characteristics. Flight, defense, and critical distances are specific, within certain boundaries, and may be accurately measured. When a wild animal is brought into a captive situation, this escape reaction becomes artificially modified to the presence of man.

The following table outlines the degrees of relationship between animal and man (Hediger, 1950).

Table I. *Diagram of possible Animal-Man Relationships*

Wild Animal		Transition	Domestic Animal	
wild	Freedom Capture Captivity			
intermediate (Half wild, half tame)	Adaptation Adapted Taming			
tame	Tameness–Generations–Domestication–Domesticity Training Fully Trained		Training Fully Trained	*domesticated*

To adapt an animal to captivity means to reduce its flight tendency; to lessen its flight distance in regards to man. Taming means the artificial removal of the flight tendency, and this intermediate stage leads to tameness. Tameness means the lack of flight tendency and thus of flight distance, that is, it means emotional stability (flight tendency has been reduced to zero). It is very important to note at this time that not every animal captured wild can make this change or accomplish the various stages of adaptation and taming. Individual differences in behavioral disposition and temperament can effect a profound delay on this transition, and improper handling or inappropriate responses to displayed aggression can further complicate the situation. Additionally, there is evidence to suggest that wild animals habituated to people at a young age may establish a basis for the formation of filial attachments with a particular individual or class of individuals other than its own species. This difference from regular species-specific behavior may be attributed to the inclusion of humans into that particular animal's social interactions. In the case of an animal like a sea lion, a large carnivore that in general engages in physically aggressive social interactions, the incorporation into that animal's social dynamics can include dangerous physical contact and injurious biting. This fact alone provides a sound argument for having animals that have been socialized to humans handled only by experienced professionals who can read and accurately recognize the displayed social precursors to aggression (Schusterman, Gisiner, & Hanggi, 1992).

Beginning in the late 1980's a transition began to take form in the zoological community in regards to the way that elephants were managed. Elephants are responsible for injuring more zoo keepers than any other animal. In the United States alone between the years 1977-1992, 15 keepers were killed by elephants (Priest, 1992). Due to an increasing public awareness of animal welfare, keeper safety concerns and a continuing need to maintain the health of the elephant collection, a new form of elephant management evolved based on established operant

conditioning practices of shaping and reinforcement in a system known as "protected contact". While the majority of references to this technique are associated with elephants, it has also been used with success with a variety of other large animals, including rhinos and giraffes. Nomenclature from the AZA Elephant Management Guidelines define four current approaches to this management technique: free contact, protected contact, confined contact and no contact (Otten, 1994).

Free contact: Direct handling of an elephant when the keeper and the elephant share the same unrestricted space. Neither the use of chains nor the posture or position of the elephant alters this definition.
Protected contact: Handling of an elephant when the keeper and the elephant do not share the same unrestricted space. Typically in this system, the keeper has contact with the elephant through a protective barrier of some type, while the elephant is not spatially confined and may leave the work area at will.
Confined contact: Handling of an elephant through a protective barrier where the elephant is spatially confined as in an ERC (Elephant Restraining Chute).
No contact: Handling of an elephant with no contact made unless the elephant is chemically sedated.

The New England Aquarium has utilized a training technique in working with an aggressive sea lion that involved working it from a distance (Montague, 1994). This specialized approach alleviated any type of fight or flight related reactions towards the trainer, and demonstrated that even an animal of unpredictable temperament could be worked successfully in a free contact scenario. It was decided to use this handling technique, in conjunction with confined contact protocols, to employ our notably aggressive animal for the hearing threshold study.

INCORPORATION OF BEHAVIORS INTO THE EXPERIMENT

Because all current pinniped underwater hearing thresholds have been obtained in shallow water, the theoretical issues addressed by this experiment were threefold:

1.) Increasing awareness of acoustic habitat degradation caused by:
2.) Increasing levels of manmade noise in the ocean and an acoustic susceptibility in deep ocean to anthropogenic sound and;
3.) Lack of a realistic idea of what pinnipeds are capable of hearing at depth (i. e. a possible under estimating of auditory sensitivity in regards to free-ranging animals based on shallow water data).

This information would be most useful to ongoing research programs such as the Acoustic Thermometry of Ocean Climate (ATOC) Program where low frequency sound is being generated to accurately measure temperature averages over the ocean basin with the goal of determining global oceanic climate variations and trends.

Project "Deep Seal" (as it came to be known) was proposed by Dr. Ronald Schusterman from the University of California, Santa Cruz to answer such questions regarding dive depth on the auditory sensitivity of pinnipeds. Similar hearing threshold studies were being conducted at

Santa Cruz, but none took into account the effects of depth and pressure. The experimental procedure required training the animal to enter a cage on a boat for transport from the pen enclosure to the work site at sea six to ten miles away (10-16 kilometers), depending on required depth. Once on station, the animal would swim down and position itself by holding onto a biteplate attached to a listening apparatus platform. After becoming situated and calm, a trial sequence would commence by having a light go on for a period of four seconds, followed by an inter-trial interval (or I.T.I.) of two seconds. Each trial cycle therefore was approximately six seconds long, and ten could be run in about a minute. On a "positive" trial sequence, a tone was presented sometime during the four seconds with a length of approximately five hundred milliseconds. Its presentation was kept random within the four second window. On a "negative" trial sequence, no tone was given during the four second window. If the animal heard the tone it would respond by touching a paddle. If it did not hear the tone, or if it were a negative trial, it would remain stationed on the biteplate. The light sequence served the purpose of delineating an opportunity for response and helped to focus the animal's attention. Trial cycles were varied randomly from approximately six to ten trials per dive, and dives per work session were also randomized based on a variety of factors (i.e. current noise levels at the work site, weather, relative difficulty of task, equipment issues, animals general attention and motivation level etc.). Testing depths were ten, fifty and one hundred meters.

The subject used for this experiment, who goes by "Newman", was a twelve year old neutered male sea lion that was collected from San Nicholas Island in 1987. He was initially trained for the MK5 Object Recovery Program, but in the course of this training his aggressive disposition became apparent and several personnel were badly injured. This behavior was consistent over time and under a variety of circumstances. He was eventually removed from a normal work schedule and placed in a separate enclosure with one older, non-working animal. He remained on a restricted work schedule for nearly seven years, and was therefore available for use when this experiment was proposed. He is a particularly nervous animal, very high strung by nature and has never fully adapted to or become tame in the captive environment. All incidents of aggression have taken place while the trainer was in close proximity to him.

From the beginning of Deep Seal, emphasis was placed on putting a consistent amount of space between the trainer and the subject animal at all times. A target pole was used, and the animal trained to station on it, so that a distance of four to six feet (1.2 to 1.8 meters)could be consistently maintained. Another technique used frequently during the initial training in the pen were "A to B's" where the animal was trained to go to a specific area and remain until released by the trainer (see diagram #1).

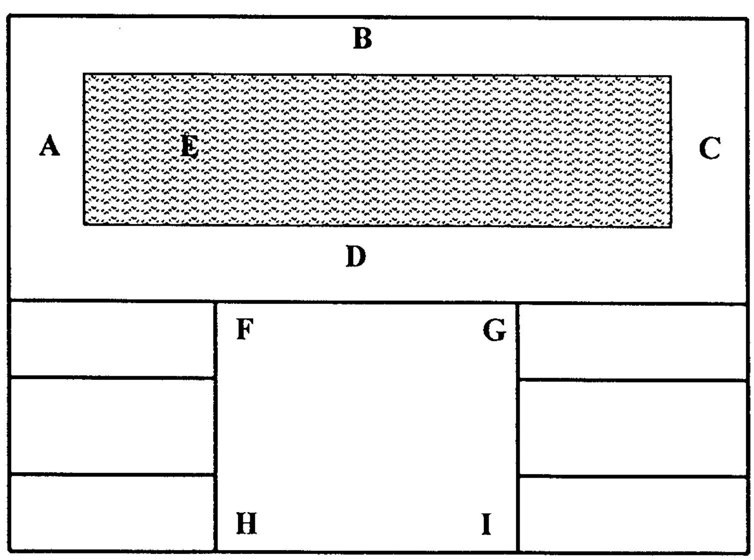

Diagram #1.

For example, if working in the common area and the trainer was near point 'H' the animal might be sent to point 'G' and asked to stay there until the door to a side enclosure were opened at which time the animal would be released and instructed to enter the side pen. For the initial discrimination training in the pool, the trainer would be at point 'C' to watch the task as it was being performed, and after the bridge would point to either 'B', 'D', or 'A' in order to reinforce the animal. If the animal was fed in the water, it was done at position 'E'. During this initial discrimination training, when the animal was recalled for an incorrect response and sent to a control point for a brief time-out, there were several instances of displaced aggression that manifested themselves with the animal ripping the neoprene off the biteplate of the listening apparatus or, if a hapless seagull were in the general area, by going after it.

As the training progressed onto the boat for transport to the work site at sea several miles away, a procedure was developed to alleviate potential problems that could arise due to the cramped quarters onboard. The animal was trained to go from the transport cage to the listening apparatus and return. Those were the two control points. If problems arose during the session where performance or control were poor, or if the animal was not interested in the task, by being in a cage verses the bow of a boat (as other programs have been operated) any kind of aggressive behaviors related to frustration were alleviated. As the experiment evolved we found that this approach was not entirely practical; by the time the listening apparatus reached a depth in excess of one hundred feet (30 meters), each dive was beginning to take a substantial period of time. First of all, the amount of time to swim from the surface to the apparatus itself and return was steadily increasing. Secondly, because each trial sequence ran a total of six seconds, and were presented in numbers that reached up to ten trials per dive, some dives were taking up to two minutes or longer. It was found that putting the animal into the cage after each and every dive was logistically time-consuming and redundant. The repetitive nature of this routine seemed to hinder the whole operation and eliminated any kind of momentum obtained. A compromise was developed that still maintained a set distance between the animal and the trainer by having the animal sit at the cut-out of the boat between sets of dives. This worked well, and had the added benefit of allowing the trainer to increase the amount of variability within the work session by changing up how many dives were performed between each break inside the cage.

Finally, as the task increased in difficulty and duration, a few control problems did materialize that involved the animal leaving the work station and making his way back to the home pens. Because of Newman's established disposition, conventional methods of tracking him were not practical because he would not allow a harness to be placed on him. Each animal in the MK5 program is fitted for a harness which supplies a means of attachment for a leash or a tether and any sort of tracking device. It also provides a means of identifying the animal and simplifies separating it out from a group of indigenous sea lions. Due to the safety concerns associated with trying to get Newman to accept a harness, a modified strap design was created that allowed a pinger device to be attached to the front pectoral flipper. Training was initiated whereby the animal would voluntarily go into a squeeze cage and stick various parts of his body through the bars for manipulation by the trainer. During the initial steps of this procedure he appeared very tense and uncomfortable, and directed his aggression at the target pole used to position his head away from the trainer or by forcefully biting at the bars of the squeeze cage. As he habituated to the process he became noticeably calmer and accepting of the whole procedure.

Several other advantages became apparent by applying this confined contact management approach. Not only was Newman trained to calmly accept a pectoral pinger device for identification and tracking purposes, but he also allowed us to manipulate various appendages for

medical inspections and treatment. None of these procedures could have been performed previously without involving some degree of risk, or requiring a large part of the available staff to operate the squeeze cage and fully immobilize the animal. The behavior has been invaluable for care and husbandry applications.

RESULTS AND CONCLUSIONS

For the entire duration of the experiment, by consistently maintaining a set distance around the animal at all times, utilizing control points in more restricted quarters and going to a confined contact handling scenario when actual physical manipulation was required, not a single incidence of aggression towards the trainer occurred. Newman proved himself to be quite reliable and went from a hands-off, minimum work schedule to providing hearing threshold data at nearly one hundred meters in the open ocean environment in a ten month period. This accomplishment is at least equal to that of an experienced, non-aggressive animal currently undergoing training at SSC San Diego.

Through the application of this specialized approach it has been successfully demonstrated that even animals of questionable temperament can be handled safely and reliably, and with comparable results in relation to other trained and working animals.

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